

WHAT IS CLAIMED IS:

1           1.       A computer implemented method for allowing communication among  
2     processing nodes in a system, comprising:  
3           receiving, in a source node, a request from a source object executing in the source node  
4     to send a message to a destination object executing in a destination node, wherein each node  
5     includes a processor capable of multitasking multiple program objects and a communication  
6     interface to transmit and receive data with the other nodes;  
7           determining, in the source node, whether the destination node and source node are a  
8     same node;  
9           sending, in the source node, the message to the destination object within the source  
10    node if the destination node is the source node; and  
11          if the destination node is not the source node, performing:  
12                  (i) transmitting, with the source node, the message to the destination node  
13                  through the communication interface; and  
14                  (ii) sending, with the destination node, the message to the destination object  
15                  within the destination node.

1           2.       The method of claim 1, wherein there is a message queue associated with each  
2     object in each node, and wherein sending, in the source node, the message to the destination  
3     object comprises:  
4           invoking, in the source node, an operating system command to transmit the message to  
5     the message queue associated with the destination object.

1           3.       The method of claim 1, wherein transmitting, with the source node, the message  
2     to the destination node over the communication interface, comprises:  
3           determining, in the source node, an address of the destination node that addresses the  
4     destination node when transmitting messages through the communication interface;

5           generating, in the source node, at least one message packet including the message, the  
6   determined address, and an address of the destination object; and  
7           transmitting, with the source node, the at least one message packet to the destination  
8   node over the communication interface.

1           4.       The method of claim 3, wherein the communication interface comprises a bus  
2   and wherein including the address of the destination node in the message causes the destination  
3   node to read the at least one message packet transmitted on the bus.

1           5.       The method of claim 1, wherein sending the message to the destination object in  
2   the destination node comprises:  
3           determining, in the destination node, the destination object for the at least one message  
4   packet;  
5           extracting, in the destination node, the message from the message packet; and  
6           invoking, in the destination node, an operating system command to transmit the message  
7   to the message queue associated with the destination object.

1           6.       The method of claim 1, wherein transmitting, with the source node, the message  
2   to the destination node comprises:  
3           invoking an operating system command, with the source object, to send the message to  
4   a message queue associated with a source network object in the source node;  
5           determining, with the source network object, an address of the destination node that  
6   addresses the destination node when transmitting messages through the communication  
7   interface;  
8           generating, with the source network object, at least one message packet including the  
9   message, the determined address of the destination node, and an address of the destination  
10   object;

11 transmitting, with the source network object, the at least one message packet to the  
12 destination node over the communication interface; and  
13 receiving, with a destination network object, the at least one message packet, wherein  
14 the destination network object sends the message to a message queue associated with the  
15 destination object in the destination node.

1 7. The method of claim 6, wherein routing the message, with the destination  
2 network object in the destination node, to the destination object comprises:  
3 determining the destination object for the at least one message packet;  
4 extracting the message from the message packet; and  
5 invoking an operating system command to transmit the message to a message queue  
6 associated with the destination object.

1 8. The method of claim 1, wherein each node is associated with one component of  
2 a system, wherein a first node comprises a controller node and at least one second node  
3 comprises a component node that controls an electro-mechanical component of the system,  
4 wherein the source object comprises a work management object in the controller node that  
5 manages system commands and the message includes a command to instruct a motion object in  
6 the component node to control the electro-mechanical component to perform an operation.

1 9. The method of claim 8, wherein a communication node is capable of receiving  
2 commands from a host system to control the electro-mechanical component of the system,  
3 further comprising:  
4 receiving, with a host communication object executing in the communication node, a  
5 command from a host system to instruct the motion object to control the electro-mechanical  
6 component of the system;

7 generating, with the host communication object, a message including the command to  
8 send to the work management object; and  
9 transmitting, with communication node, the message to the controller node to route to  
10 the work management object.

1 10. The method of claim 8, wherein the system comprises a storage library system,  
2 and the electro-mechanical component comprises a component of a storage library system.

1 11. The method of claim 1, wherein each object is assigned a unique object  
2 identifier in the system, and wherein the unique identifier is used within all nodes to identify the  
3 destination object to receive the message.

1 12. The method of claim 11, wherein each node is assigned a unique node identifier  
2 used within all nodes to identify the destination node to receive the message.

1 13. The method of claim 12, wherein a function call receives the request from the  
2 source object to send the message to the destination object, determines whether the destination  
3 node is the same node, sends the message to the destination object or causes the transmittal of  
4 the message to the destination node over the communication interface, and maintains the object  
5 and node identifier assignment, further comprising:  
6 updating the node and object identifier used by each function call in each node to reflect  
7 a modification to the arrangement of nodes or objects in the system.

1 14. The method of claim 1, wherein each node transmits signals to determine an  
2 availability of other nodes on the communication interface.

1           15.     A system for allowing communication among processing nodes in a system,  
2 comprising:  
3           at least two nodes, wherein each node includes a processor capable of multitasking  
4 multiple program objects;  
5           a communication interface to transmit and receive data between the nodes;  
6           source program logic implemented in the nodes, wherein the node executing the source  
7 logic comprises a source node, wherein the source program logic causes the source node  
8 processor to perform:  
9           (i) receiving a request from a source object executing in the source node to  
10          send a message to a destination object executing in a destination node,  
11          (ii) determining whether the destination node and source node are a same node;  
12          (iii) sending the message to the destination object within the source node if the  
13          destination node is the source node; and  
14          (iv) transmitting the message to the destination node through the communication  
15          interface if the destination node is not the source node; and  
16          destination program logic implemented in the nodes, wherein the node executing the  
17 destination logic comprises a destination node, wherein the destination program logic causes the  
18 destination node processor to send the message received from the source node to the  
19 destination object within the destination node.

1           16.     The system of claim 15, wherein there is a message queue associated with each  
2 object in each node, and wherein the source program logic sends the message to the destination  
3 object by invoking an operating system command to transmit the message to the message queue  
4 associated with the destination object.

1           17.     The system of claim 15, wherein the source program logic node transmits the  
2 message to the destination node over the communication interface by:

3           determining an address of the destination node that addresses the destination node  
4   when transmitting messages through the communication interface;  
5           generating at least one message packet including the message, the determined address,  
6   and an address of the destination object; and  
7           transmitting the at least one message packet to the destination node over the  
8   communication interface.

1           18.    The system of claim 17, wherein the communication interface comprises a bus  
2   and wherein including the address of the destination node in the message causes the destination  
3   node to read the at least one message packet transmitted on the bus.

1           19.    The system of claim 15, wherein the destination program logic for sending the  
2   message to the destination object in the destination node comprises:  
3           determining the destination object for the at least one message packet;  
4           extracting the message from the message packet; and  
5           invoking an operating system command to transmit the message to the message queue  
6   associated with the destination object.

1           20.    The system of claim 15, wherein the source program logic includes an operating  
2   system command and a source network object to transmit the message to the destination node  
3   by:  
4           invoking the operating system command, with the source object, to send the message to  
5   a message queue associated with the source network object in the source node;  
6           determining, with the source network object, an address of the destination node that  
7   addresses the destination node when transmitting messages through the communication  
8   interface;

9           generating, with the source network object, at least one message packet including the  
10   message, the determined address of the destination node, and an address of the destination  
11   object;  
12           transmitting, with the source network object, the at least one message packet to the  
13   destination node over the communication interface; and  
14           wherein the destination program logic includes a destination network object that  
15   receives, the at least one message packet, wherein the destination network object sends the  
16   message to a message queue associated with the destination object in the destination node.

1           21.    The system of claim 20, wherein the destination network object routes the  
2   message in the destination node to the destination object by:  
3           determining the destination object for the at least one message packet;  
4           extracting the message from the message packet; and  
5           invoking an operating system command to transmit the message to a message queue  
6   associated with the destination object.

1           22.    The system of claim 15, wherein each node is associated with one component  
2   of a system, wherein a first node comprises a controller node and at least one second node  
3   comprises a component node that controls an electro-mechanical component of the system,  
4   wherein the source object comprises a work management object in the controller node that  
5   manages system commands and the message includes a command to instruct a motion object in  
6   the component node to control the electro-mechanical component to perform an operation.

1           22.     The system of claim 21, further comprising:  
2           a communication node capable of receiving commands from a host system to control  
3     the electro-mechanical component of the system, wherein the communication node includes a  
4     host communication object executing in the communication node performing:  
5           receiving a command from a host system to instruct the motion object to control  
6     the electro-mechanical component of the system;  
7           generating a message including the command to send to the work management  
8     object; and  
9           transmitting the message to the controller node to route to the work  
10    management object.

1           23.     The system of claim 21, wherein the system comprises a storage library system,  
2     and the electro-mechanical component comprises a component of a storage library system.

1           24.     The system of claim 15, wherein each object is assigned a unique object  
2     identifier in the system, and wherein the unique identifier is used within all nodes to identify the  
3     destination object to receive the message.

1           25.     The system of claim 24, wherein each node is assigned a unique node identifier  
2     used within all nodes to identify the destination node to receive the message.

1           26.     The system of claim 25, wherein the source and destination program logic  
2     includes a function call that receives the request from the source object to send the message to  
3     the destination object, determines whether the destination node is the same node, sends the  
4     message to the destination object or causes the transmittal of the message to the destination  
5     node over the communication interface, and maintains the object and node identifier assignment,  
6     wherein the nodes further include program logic performing:



7 updating the node and object identifier used by each function call in each node to reflect  
8 a modification to the arrangement of nodes or objects in the system.

1 27. The system of claim 15, wherein each node transmits signals to determine an  
2 availability of other nodes on the communication interface.

1 28. An article of manufacture for allowing communication among processing nodes  
2 in a system, wherein each node includes a processor, wherein a communication interface  
3 enables communication between the nodes, wherein the article of manufacture includes program  
4 logic for controlling the node processor operations, comprising:  
5 source program logic implemented in the nodes, wherein the node executing the source  
6 logic comprises a source node, wherein the source program logic causes the source node  
7 processor to perform:  
8 (i) receiving a request from a source object executing in the source node to  
9 send a message to a destination object executing in a destination node,  
10 (ii) determining whether the destination node and source node are a same node;  
11 (iii) sending the message to the destination object within the source node if the  
12 destination node is the source node; and  
13 (iv) transmitting the message to the destination node through the communication  
14 interface if the destination node is not the source node; and  
15 destination program logic implemented in the nodes, wherein the node executing the  
16 destination logic comprises a destination node, wherein the destination program logic causes the  
17 destination node processor to send the message received from the source node to the  
18 destination object within the destination node.

1 29. The article of manufacture of claim 28, wherein there is a message queue  
2 associated with each object in each node, and wherein the source program logic sends the

3 message to the destination object by invoking an operating system command to transmit the  
4 message to the message queue associated with the destination object.

1           30.     The article of manufacture of claim 28, wherein the source program logic node  
2 transmits the message to the destination node over the communication interface by:  
3           determining an address of the destination node that addresses the destination node  
4 when transmitting messages through the communication interface;  
5           generating at least one message packet including the message, the determined address,  
6 and an address of the destination object; and  
7           transmitting the at least one message packet to the destination node over the  
8 communication interface.

1           31.     The article of manufacture of claim 30, wherein the communication interface  
2 comprises a bus and wherein including the address of the destination node in the message  
3 causes the destination node to read the at least one message packet transmitted on the bus.

1           32.     The article of manufacture of claim 28, wherein the destination program logic  
2 for sending the message to the destination object in the destination node comprises:  
3           determining the destination object for the at least one message packet;  
4           extracting the message from the message packet; and  
5           invoking an operating system command to transmit the message to the message queue  
6 associated with the destination object.

1           33.     The article of manufacture of claim 28, wherein the source program logic  
2 includes an operating system command and a source network object to transmit the message to  
3 the destination node by:

4           invoking the operating system command, with the source object, to send the message to  
5   a message queue associated with the source network object in the source node;  
6           determining, with the source network object, an address of the destination node that  
7   addresses the destination node when transmitting messages through the communication  
8   interface;  
9           generating, with the source network object, at least one message packet including the  
10   message, the determined address of the destination node, and an address of the destination  
11   object;  
12          transmitting, with the source network object, the at least one message packet to the  
13   destination node over the communication interface; and  
14          wherein the destination program logic includes a destination network object that  
15   receives, the at least one message packet, wherein the destination network object sends the  
16   message to a message queue associated with the destination object in the destination node.

1           34.     The article of manufacture of claim 33, wherein the destination network object  
2   routes the message in the destination node to the destination object by:  
3           determining the destination object for the at least one message packet;  
4           extracting the message from the message packet; and  
5           invoking the operating system command to transmit the message to a message queue  
6   associated with the destination object.

1           35     The article of manufacture of claim 28, wherein each node is associated with  
2   one component of a system, wherein a first node comprises a controller node and at least one  
3   second node comprises a component node that controls an electro-mechanical component of  
4   the system, wherein the source object comprises a work management object in the controller  
5   node that manages system commands and the message includes a command to instruct a motion

6 object in the component node to control the electro-mechanical component to perform an  
7 operation.

1 36. The article of manufacture of claim 28, wherein a communication node receives  
2 commands from a host system to control the electro-mechanical component of the system,  
3 wherein the communication node includes a host communication object executing in the  
4 communication node performing:  
5 receiving a command from a host system to instruct the motion object to control the  
6 electro-mechanical component of the system;  
7 generating a message including the command to send to the work management object;  
8 and  
9 transmitting the message to the controller node to route to the work management  
10 object.

1 37. The article of manufacture of claim 35, wherein the system comprises a storage  
2 library system, and the electro-mechanical component comprises a component of a storage  
3 library system.

1 38. The article of manufacture of claim 28, wherein each object is assigned a unique  
2 object identifier in the system, and wherein the unique identifier is used within all nodes to  
3 identify the destination object to receive the message.

1 39. The article of manufacture of claim 38, wherein each node is assigned a unique  
2 node identifier used within all nodes to identify the destination node to receive the message.

1 40. The article of manufacture of claim 39, wherein the source and destination  
2 program logic includes a function call that receives the request from the source object to send

3 the message to the destination object, determines whether the destination node is the same  
4 node, sends the message to the destination object or causes the transmittal of the message to  
5 the destination node over the communication interface, and maintains the object and node  
6 identifier assignment, wherein the nodes further include program logic performing:  
7 updating the node and object identifier used by each function call in each node to reflect  
8 a modification to the arrangement of nodes or objects in the system.

1 41. The article of manufacture of claim 28, wherein each node transmits signals to  
2 determine an availability of other nodes on the communication interface.

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